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NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

To:

JOHANSSON, Folke
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1. The following indications appeared on record concerning:

[ ] the applicant [ ] the inventor [X] the agent [ ] the common representative

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PATENT COOPERATION TREATY

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NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

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Applicant SALONAHO, Oscar et al	

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09 September 1999 (09.09.99)

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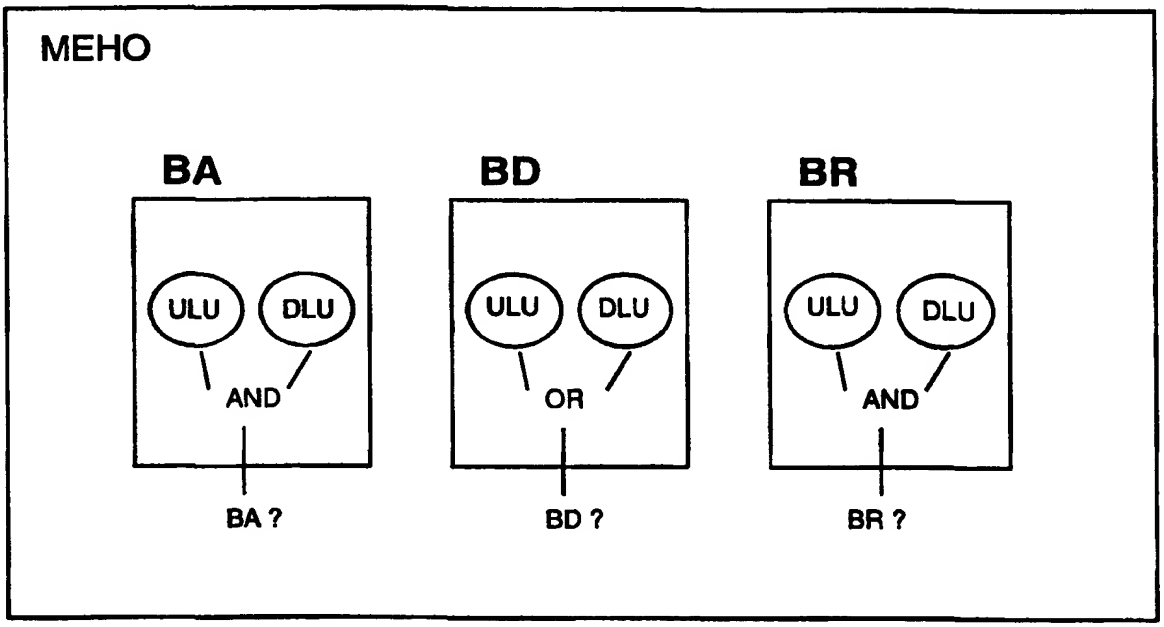

(57) Abstract

The basic idea of this invention is to define triggers, e.g. threshold values for radio signal parameters, for sending a measurement report separately for downlink and uplink directions. In addition, it is specified how the outputs of these triggers are to be combined. For example, it may be determined whether the measurement report is to be sent, for example, when both the uplink and downlink conditions are met, when either of them is met, based entirely on the downlink conditions or based entirely on the uplink conditions.

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Measurement reporting in a telecommunication system

Field of the invention

This invention concerns reporting of measurements on radio interface in a telecommunication system.

Background of the invention

In mobile telecommunication systems mobile stations MS can use the services provided by the network using radio connections. The radio connection uses the channels of called radio interface between the mobile station and a base station of the mobile telecommunication network. Only a limited bandwidth on the radio spectrum is allocated to be used by the telecommunication systems. To gain capacity enough, the channels must be used again as densely as possible. To achieve this, the coverage area of the system is divided into cells, each cell being served by one base station. Due to this, the mobile telecommunication systems are often also called cellular systems.

The network elements and the internal relation between the network elements of a mobile telecommunication system are presented in Figure 1. The network presented in the figure is in accordance with the UMTS system currently being standardized by ETSI (European Telecommunications Standards Institute). The network comprises base stations BTS (Base Transceiver Station), that can establish connections with the mobile stations MS, Radio Network Controllers RNC controlling the usage of base stations and Mobile Switching Centers MSC controlling the RNC's. In addition, the network comprises a Network Management System NMS, with the help of which the operator can modify the parameters of the other network elements. The interface between the MSC and the RNC's is generally called the Iu interface. The interface between the RNC's and the BTS's is the Iubis interface and the interface between the BTS and the MS's the radio interface. According to some proposals, an interface Iur between the RNC's is specified.

The calls of a mobile station are routed from the BTS via the RNC to the MSC. MSC switches the calls to other mobile switching centers or to

the fixed network. The calls can as well be routed to another mobile station under the same MSC, or possibly even under the same BTS.

The radio interface between the base stations and the mobile stations may be divided into channels using a plurality of divisions. Known methods of division are, for example, Time Division Multiplexing TDM, Frequency Division Multiplexing FDM and Code Division Multiplex CDM. In TDM systems, the spectrum allocated for the system is divided into successive time frames consisting of time slots, each time slot defining one channel. In FDM the channel is defined by the frequency used in the connection. In CDM the channel is defined by the spreading code used in the connection. These methods can be used separately or be combined.

To be able to successfully communicate with the mobile telecommunications network, the mobile station continuously monitors the radio signals sent by the base stations. In the idle mode the mobiles decode the strongest signal received, and when needed request the establishment of a connection from the base station transmitting this signal.

During an active connection, the connection can be moved from one base station to another. The connection can be moved from one base station to another by simply rerouting the signal, which is called hard handover. The system interference can be decreased and thus the capacity increased especially in CDMA (Code Division Multiple Access) systems utilizing CDM by using soft handovers in which the mobile has simultaneously connections with a plurality of base stations, these base stations forming the so called active set of the connection.

The handover may be

- intra-cell handovers
- inter-cell handovers between two base stations under the same radio network controller
- inter-RNC handovers between two RNC's under the same MSC, or
- inter MSC handover between two cells under different MSC's.

In addition, the handover can be divided into intra-frequency handovers in which all the channels involved in the handover procedure are on the same frequency and inter-frequency handovers, in which there are channels from at least two frequencies involved in the handover procedure.

To be able to establish the handovers to right base stations during an active connection, the mobile station continuously measures the radio

signals from the base stations it is in connection with as well as their neighboring base stations. The measurement results are transmitted to the network using the measurement reporting scheme specified in the system. Based on the reports, the network initiates the handover when the mobile station would have a better or at least sufficiently good radio connection to another base station.

In addition to the network initiated handovers, also mobile evaluated handovers are known. In an exemplary description of a mobile evaluated handover, the mobile station monitors the signal levels received from neighboring base stations and reports to the network those beacon signals which are above or below a given set of thresholds. Those thresholds can be dynamically adjusted as will be explained in the following. Based on this reporting scheme, the network will decide whether the active set of the connection is to be changed.

Two type of thresholds are used: the first one to report beacons with sufficient power to be used for coherent demodulation, and the second one to report beacons whose power has declined to a level where it is not beneficial to be used for receiving the sent information. Based on this information, the network orders the MS to add or remove base station signals from its active set.

While soft handover improves overall performance it may in some situations negatively impact system capacity and network resources. This is due to the unnecessary branches between the MS and the base stations in the active set. On the downlink direction from the base stations to the mobile station, excessive branch reduces system capacity while on the uplink direction from the mobile station to the base stations, it costs more network resources.

To solve this problem, the principle of dynamic thresholds for active set management is known in prior art. In this method, the MS detects beacons crossing a given static threshold T1. When crossing this threshold the beacon is moved to a candidate set. It is then searched more frequently and tested against a second dynamic threshold T2. This second threshold T2 will test if the beacon is worth adding to the active set.

When the beacons corresponding to the branches in the active set are weak, adding an additional branch signal, even a poor one, will improve performance. In these situations, a relatively low value of T2 is used. When there is one or more dominant beacons, adding an additional weaker branch

whose beacon signal is above T1 will not improve performance but will utilize more network resources. In these situations a higher value of T2 is used.

After detecting a base station signal above T2, the MS will report it back to the network. The network will then set up the handover resources and order the MS to coherently demodulate the signal of this additional branch.

Beacons can be dropped from the active set according to the same principles. When the beacon strength decreases below a dynamic threshold T3, the handover connection is removed, and the beacon is moved back to the candidate set. The threshold T3 is a function of the total energy of beacons in the active set. When beacons in the active set are weak, removal a branch, even a weak one, will decrease performance. In these situations, a relatively low value of T3 is used. When there is one or more dominant branches, removal of a weaker signal will not decrease performance but will make the utilization of the network resources more efficient. In these situations a higher value of T3 is used. Branches not contributing sufficiently to the total received energy will be dropped. When further decreasing below a static threshold T4 a beacon is removed from the candidate set.

To be able to control the connection, the network needs in different situations different kinds and different amount of measurement information. The more information is sent the more efficient the handover algorithm are. However, the more information the mobile station sends the network, the more radio resources are spent. Thus, the measurement reporting schemes according to prior art are always compromises between the efficiency of the handover algorithms and the usage of radio resources.

As the usage of mobile telecommunication systems and multimedia applications requiring large bandwidths is growing the present methods are no longer sufficient, thus limiting the performance of the mobile telecommunication networks. The objective of the present invention is a flexible measurement reporting scheme which solves this problem.

Summary of the invention

The basic idea of this invention is to define triggers, e.g. threshold values for radio signal parameters, for sending a measurement report separately for downlink and uplink directions. In addition, it is specified how

the outputs of these triggers are to be combined. For example, it may be determined whether the measurement report is to be sent, for example, when both the uplink and downlink conditions are met, when either of them is met, based entirely on the uplink conditions or based entirely on the downlink conditions.

The measurement report types is preferably a mobile evaluated handover measurement report triggering a handover. Such a report is triggered in the mobile station when at least one upper threshold of the radio signal parameters for a mobile evaluated handover is exceeded or lower threshold gone under.

Brief description of the figures

The invention is described more closely with reference to the accompanying schematic drawings, in which

Figure 1 shows a mobile telecommunication system;

Figure 2 shows the structure of a MEHO algorithm;

Figures 3, 4, 5, 6 and 7 each show a decision flow chart, and

Figure 8 shows functional entities in a mobile station.

Detailed description of the invention

In the following, preferred embodiments of the invention are studies further.

In this context mobile evaluated handover means, that a handover measurement algorithm situated in the mobile triggers the handover report. The actual HO decision is always performed by the network. The handover report types can be further divided into intra-frequency and inter-frequency handover report types.

The intra-frequency handover

The algorithm presented in the following includes the possibility to use information about the downlink (DL), uplink (UL) or both as the trigger for the HO report. Also this scheme provides a flexible means to control the information content of the HO report. The actual thresholds and timers in the algorithm are selected to be such, that a wide variety of HO algorithms can be constructed by the appropriate setting of these

The mobile station continuously performs measurements on the radio signals from different BTS's according to the procedure described in the following.

The mobile determines the received power of the beacon channel for BTSi. This power is denoted as Prx,i (mW). The MS performs this measurement for time period t (a parameter set by network). The value of $P_{rx,i}$ is averaged over the measurement period. The result of this operation is denoted as $P\_ave_{rx,i}$. When the measurement is completed, the path loss estimate, denoted as Li (dB), is calculated as:

$$L_i = -10\log_{10}\left(\frac{P\_ave_{rx,i}}{P\_beacon_{tx,i}}\right). \quad (1)$$

In (1), the unit of $P\_beacon_{tx,i}$ is mW.

During the same measurement period t the MS also estimates the interference power of the beacon channel before or after (this is preferably a parameter defined by the network) correlating the received sum signal with the spreading code. The values calculated before or after the correlation differ due to the fact that the correlation remarkably reduces the interference caused by other connections. This interference is denoted as I_i (mW). The interference is also averaged over the measurement period. After the averaging has been performed, the average value is converted into dBm. This average is denoted as I_ave_i.

The MS is also to receive, e.g. on the beacon channel, the DL_offset value of BTS_i, denoted as DL_offset_i (dB), which is a relatively stable parameter and there is thus no need to re-receive it for each measurement period. The purpose of this base station specific parameter is to specify fro different cell sizes. The mobiles are handed over from a first set of cells more willingly than from a second set of cells. These cells of the first set thus become smaller than the cells of the other set. The offset value can be seen as an additional base station specific part of the threshold values that are soon to be presented more closely.

From the above information the MS is to calculate one DL HO measurement $S_{dl,i}$ sample as

$$S_{dl,i} = L_i + I_{ave,i} + DL\_offset_i \quad (2)$$

$S_{dl,i}$ is thus a measure for the carrier to interference ratio CIR of the measured signal. It is to be noted that the larger the value of $S_{dl,i}$, the worse the link from the base station to the mobile station is. The scope of this invention is not limited to the use of this particular measure, but other measures of the link quality may as well be used when implementing the present invention. As one example, the bit error ratio BER in the received radio signal can be used as the measure.

The MS is also to receive, e.g. on the beacon channel, the total interference power , $I_{ul,i}$ (dBm) at the BTS_i and the UL offset value, UL_offset_i (dB) of BTS_i. The MS is then to calculate the value of one UL HO measurement sample as

$$S_{ul,i} = L_i + I_{ul,i} + UL\_offset_i \qquad (3)$$

When these measurements and calculations have been performed for BTS_i the MS is then to place the results as the first elements in the vectors L_vect_i (for the value of L_i), $S\_vect_{dl,i}$ (for the value of $S_{dl,i}$) and $S\_vect_{ul,i}$ (for the value of $S_{ul,i}$). The last element of these vectors is discarded. The vectors comprise the history of the measurement results. The length of the history maintained, defined by the length n of these vectors is a network parameter.

Having performed the measurements for this base station signal the MS checks whether a MEHO (Mobile Evaluated HandOver) report is to be transmitted according to the HO algorithm described in the following. The argument of the algorithm may be for instance either median or mean of the vectors $S\_vect_{dl,i}$ and $S\_vect_{ul,i}$, and is preferable defined by the network. In addition, the MS starts to measure the beacon signal transmitted by the next BTS BTS_{i+1}.

The HO algorithm is used to trigger the transmission of the MEHO measurement report. In the algorithm the UL and DL directions of transmission are treated separately. So actually two algorithms can function in the MS independently. The network can command the MS to use either one of them or both for the triggering of measurement report transmission. It should be noted, however, that the active set is always the same for both directions of transfer.

The algorithm includes the below thresholds:

1. Branch addition threshold denoted in this document as BA_abs_{th} and BA_rel_{th},
2. Branch deletion threshold denoted in this document as BD_abs_{th} and BD_rel_{th}, and
3. Branch replacement threshold denoted in this document as BR_rel_{th}

For the thresholds 1 and 2, both an absolute and a relative threshold are defined. Separate values can be defined for the uplink and the downlink directions. The thresholds are used in Branch Addition (BA), the Branch Deletion (BD) and the Branch Replacement (BR) decision units. These units may be implemented as hardware units, software blocks or a combination of these.

The basic structure of these algorithms is presented in Figure 2. The uplink comparison unit ULU compares the measurement results of the uplink radio signals to triggers defined by the thresholds set to these signals, and outputs a logical truth value. The downlink comparison unit DLU compares the measurement results of the downlink radio signals to triggers defined by the thresholds set to these signals, and outputs a logical truth value. The results of ULU and DLU are combined to one logical signal using a logical function. The logical value may be, for example, AND or OR function, or a function outputting directly one of the input values of the block. The truth value of this signal is verified, and a report is sent if the truth value is TRUE, for example. Of course, using a different logical function when combining the outputs of ULU and DLU, it can be defined that the report is sent if the truth value is FALSE.

The parallel decision units BA, BD and BR shown in Figure 2 are used in different situations. BA is used when the base station is not in the active set of the connection, and the number of links between the MS and BTS's in the active set is less than a given limit $N_{AS,max}$. The value of $N_{AS,max}$ is a preferably a parameter set by the network.

BD is used when the base station is in the active set of the connection. To prevent ping-pong effect, the logical functions of the BA and BD blocks must be consistent so that the same measurement values for a link between the MS and a BTS may not cause both the units to trigger a measurement report suggesting an addition or deletion of the same link. For example, if logical functions AND and OR are used, the value OR may not be used in both the decision blocks.

BR is used when the base station is not in the active set of the connection and the number of links between the MS and BTS's in the active set is equal to the limit $N_{AS,max}$. This decision unit is used to replace on link of the active set by another one having better radio characteristics.

One algorithmic implementation of the downlink comparison unit DLU of the branch addition algorithm BA is shown in Figure 3. The algorithm is used for beacon signals from base stations that do not belong to the active set. At stage A1 it is checked whether the number of base stations in the active set is less than a predefined limit, i.e. whether the active set is full. As an example, the limit 3 can be used here. If the active set is full, the branch replacement algorithm is selected instead of this algorithm (stage A10).

If the active set is not full the procedure proceeds to stage A2, A3 and A4, in which

- it is checked whether new measurement results have been received (stage A2),
- $S_{i,DL}$ is compared to absolute threshold $BA\_abs_{th,DL}$, and
- $S_{i,DL}$ is compared to threshold $S\_best_{i,DL}+BA\_rel_{th,DL}$, in which $S\_best_{i,DL}$ id the value measured for the best active branch.

If new results have been received and both the threshold values $BA\_abs_{th,DL}$ and $S\_best_{i,DL}+BA\_rel_{th,DL}$ are higher than $S_{i,DL}$, the output of the DLU is set to TRUE.

The uplink branch can be implemented using a similar algorithm. If new results for the uplink have been received and both the threshold values $BA\_abs_{th,UL}$ and $S\_best_{i,UL}+BA\_rel_{th,UL}$ are higher than $S_{i,UL}$, the output of the ULU is set to TRUE. The threshold values $BA\_abs_{th,DL}$/ $BA\_abs_{th,UL}$ and $BA\_rel_{th,DL}$/ $BA\_rel_{th,UL}$ used in different directions may be different from each other or identical.

The values of the DLU and ULU algorithms are inputted into the logical function, as shown in Figure 2. MEHO measurement report is sent if the function outputs a value TRUE. For example, if the logical value used is AND, the MEHO measurement report is sent when both the ULU and DLU have value TRUE.

An algorithmic implementation of the downlink comparison unit DLU of the branch deletion algorithm BD is shown in Figure 4. This algorithm is used for beacon signals from base stations that belong to the active set.

It is first checked whether new measurement results have been received (stage D2). The measurement result $S_{i,DL}$ is compared to thresholds

$BD\_abs_{th,UL}$ (stage D3) and $S\_best_{i,DL}+BD\_rel_{th,UL}$ (stage D4). If either of these thresholds is lower than $S_{i,DL}$, the DLU is set to TRUE (stage D5). Otherwise, DLU is set to FALSE (stage D10) and the next beacon signal in the active set is measured.

A similar comparison in made between the uplink measurement results and uplink thresholds to define the value of ULU. DLU and ULU are combined using a logical function defined by the network to make a decision whether to send or not to send a MEHO measurement report. To prevent the ping-pong effect, the logical function used is selected so that the same measurement results never cause the BA to request the addition of a branch and the BD to delete the same branch. To meet this requirement, only one of the logical functions used in BA and BD algorithms according to the same reporting option may be a logical OR function. This is depicted in the following table for two different options for measurement reporting:

	Logical function for BA	Logical function for BD
Option 1	AND	OR
Option 2	OR	AND
Option 3	AND	AND

An algorithmic implementation of the downlink comparison unit DLU of the branch replacement algorithm BR is shown in Figure 5. The algorithm is used for beacon signals from base stations that do not belong to the active set. At stage R1 it is checked whether the number of base stations in the active set is equal a predefined limit, i.e. whether the active set is full. As an example, the limit 3 can be used here. If the active set is not full, the branch addition algorithm is selected instead of this algorithm (stage R10).

If the active set is full the procedure proceeds to stage in which it is checked whether new measurement results have been received (stage R2). If no new measurement results have been received, the next beacon signal is studied. If new measurement result $S_{i,DL}$ has been received it is compared at stage R3 to the measurement value $S\_worst_{i,DL}$ of the worst link in the active set. If $S\_worst_{i,DL}$ exceeds $S_{i,DL}$ with a margin of BR_rel_{th} DLU is set to TRUE (stage R4). Otherwise ULU is set to FALSE (stage R20) and the measurements on a next BTS not belonging to the active set studied.

The uplink branch can be implemented using a similar algorithm. In this comparison, $S_{i,UL}$ is compared to $S\_worst_{i,DL}$ of the worst link in the active set. If $S_{i,DL}$ exceeds $S\_worst_{i,DL}$ with a margin of BR_rel_{th} DLU is set to TRUE. The margin values BR_rel_{th} are preferably identical in downlink and uplink directions, but also different values in different directions can be used. This is a parameter that is defined by the network. DLU and ULU are combined using a logical function to make a decision whether to send or not to send an MEHO measurement report. The logical function is preferably an logical AND function. In another preferred embodiment, the logical function can be adjusted freely by the network. The output of the logical function can be, e.g. the truth value of DLU or ULU.

When the MEHO algorithms in the mobile station trigger the measurement report the status of the M best cells/sectors is transmitted. The transmitted measurement report is always to include the appropriate values for the active set. The M best cells/sectors are determined by using the values of $S_{i,dl}$ or $S_{i,ul}$ depending on whether it was DL or UL algorithm that triggered the report. The contents of the report is preferably determined with an message sent from the network. The measurement report includes, e.g. the following values for each cell/sector to be reported. These values are the filtered values.

1. $S_{i,dl}$
2. $S_{i,ul}$
3. L_i

It should be noted, that the measurement report can include information only about neighbour BTSs whose beacon signals have been decoded. Thus the handover report has to include the information of the number of BTSs that are being reported.

Also the information included in the measurement report may preferably be defined by the network. For example, the number of beacon signals whose power level is to be reported in a measurement report is preferably defined by the network.

The Inter-frequency HO

The inter-frequency measurements are always initiated by the network. Thus the mobile can perform inter-frequency MEHO only after the

network has first commanded the MS to start the inter-frequency HO measurements.

There are at least three different reasons for inter-frequency HO:

1. Coverage. The MS is e.g. exiting the coverage area of a microcell and has to hand over to a macrocell. This case may be relatively simple. For example if the branch deletion has triggered a measurement report and only one branch is active the conclusion by the network is, that the MS is exiting the coverage area. The network responds to this by transmitting a message 'start i-f measurements'. This message includes the possible candidate BTSs. The mobile would then start searching for a stronger BTS on the other frequency. The transmission of the measurement report is triggered when the MS finds a candidate BTS on the other (new) frequency that is stronger than the best active branch on the current frequency.
2. Load. If for some reason the load on the used frequency is higher than on some other available frequency an inter-frequency HO may be appropriate. This situation would probably be known only by the network. After the network has detected the overload situation the actions are the same as in case 1
3. Mobile speed. The speed of the MS is so high, that an excessive amount of handovers are needed if the MS is connected to the microcell layer. This is an item for further study. The most crucial question is the detection of the MS speed. That is, there a method to reliably estimate the MS speed? Can the received beacon powers be measured often enough to be able to use fast fading based methods? What signalling does the MS use to indicate its' speed if the estimation is in the mobile?

After the MS has been commanded by the network to start the inter-frequency measurements the MS is to perform the measurements on the frequency given in the start measurement command.

The algorithm is used to trigger the transmission of the inter-frequency measurement report. In the algorithm the UL and DL directions of transmission are treated separately. So, actually two decision algorithms, DLU and ULU function in the MS independently. The outputs of these

algorithms are combined as shown in Figure 2 to make the final decision concerning sending the measurement report. The network can command the MS to use either one of them or both for the triggering of measurement report transmission. It should however be noted, that the active set is always the same for both directions of transfer.

The algorithm includes the below threshold. For the threshold an absolute and a relative threshold CF_abs_{th} and CF_rel_{th} are defined. The decision flow chart for DLU unit of the algorithm is shown in Figure 7.

If new measurement results have been acquired in the new frequency not belonging to the active set, the link losses the beacon signal is suffering are compared to an absolute threshold CF_abs_{th}. If the quality of the link is sufficient it is compared to the best link in the active set. If the quality is better with a predetermined margin the output of the DLU algorithm is set to TRUE.

A similar algorithm ULU is run for downlink direction. The outputs of DLU and ULU are combined using a logical function as described earlier.

When the HO algorithms trigger the inter-frequency measurement report the status of the M best cells/sectors is transmitted. The M best cells/sectors are determined by using the values of $S_{i,dl}$ or $S_{i,ul}$ depending on whether it was DL or UL algorithm that triggered the report. The contents of the report is determined with a message sent from the network. The measurement report includes, e.g. the following values for each cell/sector to be reported. These values are the filtered values.

1. $S_{i,dl}$
2. $S_{i,ul}$
3. L_i

It must be noted that the possible logical functions are not limited to those presented in the examples above. For instance, if the outputs of the DLU and ULU functions are not binary but have more levels or are even continuous functions triggered by some events on the radio signals in respective directions, fuzzy logical functions can be used when making the decision whether to send or not to send a measurement report based on the outputs of the functions DLU and ULU. The fuzzy logical functions are preferably given by the network.

A mobile station according the invention is shown in Figure 8. As its characteristics, the mobile station has

- receiving means for receiving information about first and second set of trigger conditions corresponding, respectively, to uplink and downlink signals and a logical function,
- monitoring means for monitoring the radio signals,
- checking means which is responsive to the receiving means and the monitoring means and which has the functionality of checking the state of each trigger conditions,
- combining means responsive to the checking means for combining the states according to the logical function, and
- sending means responsive to the combining means for sending a measurement report to the base station.

According to a preferred embodiment,

- the receiving means are arranged to receive a first combination of a first and a second set of trigger conditions and the logical function and a second combination of a first and a second set of trigger conditions and the logical function, and
- the checking means and the combining means are arranged to use the first combination for radio signals from or to active base stations having an active link with the mobile station and the second combination is used for radio signals from or to candidate base stations not having an active link with the mobile station.

The measurement reporting scheme according the invention provides flexible means for reporting measurement results. The advantage of the flexibility is that the measurement reporting can be adjusted to provide the network the necessary information while minimizing the amount of radio resources spent for the measurement reporting purposes.

The invention has been described above by means of preferred embodiments to illustrate the principles of the invention. As regards the details, the invention may vary within the scope of the attached claims.

Claims

1. A method of measurement reporting in a telecommunication system comprising mobile stations and a network comprising base stations, wherein decisions upon establishing or canceling a communication link between a mobile station and a base station are made in the network on the basis of measurement reports sent from the mobile station to the network,

characterized in that the method comprises the steps of

defining first and second sets of trigger conditions corresponding, respectively, to radio signal properties in the uplink and downlink directions,

defining a logical function for combining said first and second sets of trigger conditions,

at the mobile station, determining the state of each trigger condition, combining the states according to the logical function, and sending a measurement report to a base station in dependence upon the condition of the logical function.

2. A method according to claim 1, **characterized** in that the first and second set of trigger conditions are dynamically defined by the network.

3. A method according to claim 1, **characterized** in that the logical function is defined by the network.

4. A method according to any of the preceding claims **characterized** in that

a first combination of the first and second sets of trigger conditions and the logical function are defined to be used for radio signals from or to active base stations having an active link with the mobile station,

a second combination of the first and second sets of trigger conditions and the logical function are defined to be used for radio signals from or to candidate base stations not having an active link with the mobile station, and

at the mobile station, the first combination is used for radio signals from or to active base stations having an active link with the mobile station and the second combination is used for radio signals from or to candidate base stations not having an active link with the mobile station.

5. A method according to claim 4, and comprising the step of creating an active link between the mobile station and a candidate base station not having an active link with the mobile station when the network

receives from the mobile station a measurement report triggered by the radio signals from or to that candidate base station.

6. A method according to claim 4, and comprising the step of deleting an active link between the mobile station and a base station when the network receives from the mobile station a measurement report triggered by the radio signals from or to that active base station.

7. A method according to any of the claims 4 to 6, **characterized** in that said two different logical functions are such that when a base station is in the active set, a measurement report is not triggered by a radio signal of that base station for the same set of radio properties as would trigger the transmission of a measurement report when the base station is in the candidate set.

8. A method according to any one of the preceding claims **characterized** in that the method comprises a step of defining a logical function for use when the number of base stations in the active set is equal to a predefined maximum number, and defining the first and second sets of trigger conditions on the basis of the radio signal properties of the active base station having the worst signal conditions, and wherein a measurement report is triggered by a radio signal of a candidate base station causes that worst base station to be replaced by the candidate base station.

9. A method according to claim 8, **characterized** in that the maximum number is dynamically defined by the network.

10. A method according to claim 1, **characterized** in that at least one of the trigger conditions is a condition for the received power level or a function thereof.

11. A method according to claim 1 **characterized** in that at least one of the trigger conditions is a condition for the interference in the received radio signal or a function thereof.

12. A method according to claim 11 in a network using CDMA air interface in which the connections are divided using different spreading codes, **characterized** in that the value for the interference is an estimate for the interference power made before the signal is correlated with the spreading code used in the connection.

13. A method according to claim 11 in a network using CDMA air interface in which the connections are divided using different spreading codes, **characterized** in that the value for the interference is an estimate the

interference power made after the signal has been correlated with the spreading code used in the connection.

14. A method according to claims 1 or 10 to 13, **characterized** in that at least one of the sets of trigger conditions is a condition for the change of the parameters of the received radio signals or a function thereof.

15. A method according to any of claims 11 to 14, **characterized** in that the trigger conditions comprise at least one base station specific offset value.

16. A method according to claim 15, **characterized** in that at least one of the offset values is dynamically defined by the network.

17. A method according to claim 1, **characterized** in that the network informs the mobile station what information to include in the measurement report, and the mobile station includes this information in the measurement report.

18. A method according to claim 17, **characterized** in that the radio signals are ordered using a predefined condition, and in the measurement report sent from the mobile station, information about the properties of a predefined number of the best radio signals according to the condition are reported.

19. A method according to claim 17, **characterized** in that the number of radio signals to be reported is given by the network.

20. A method according to claim 17, **characterized** in that the measurement report comprises a value for the path loss for a reported signal or a function thereof.

21. A method according to claim 17, **characterized** in that the measurement report comprises a value for the carrier to interference ratio of a reported signal of a function thereof.

22. A mobile station for a telecommunication system comprising mobile stations and a network comprising base stations, wherein the mobile stations monitor the radio signals sent by the base stations,

characterized in that the mobile station has

receiving means for receiving information about first and second set of trigger conditions corresponding, respectively, to uplink and downlink signals and a logical function,

monitoring means for monitoring radio signals,

checking means which is responsive to the receiving means and the monitoring means and which has the functionality of checking the state of each trigger conditions,

combining means responsive to the checking means for combining the states according to the logical function, and

sending means responsive to the combining means for sending a measurement report to the base station.

23. A mobile station according to claim 22 **characterized** in that

the receiving means are arranged to receive a first combination of a first and a second set of trigger conditions and the logical function and a second combination of a first and a second set of trigger conditions and the logical function, and

the checking means and the combining means are arranged to use the first combination for radio signals from or to active base stations having an active link with the mobile station and the second combination is used for radio signals from or to candidate base stations not having an active link with the mobile station.

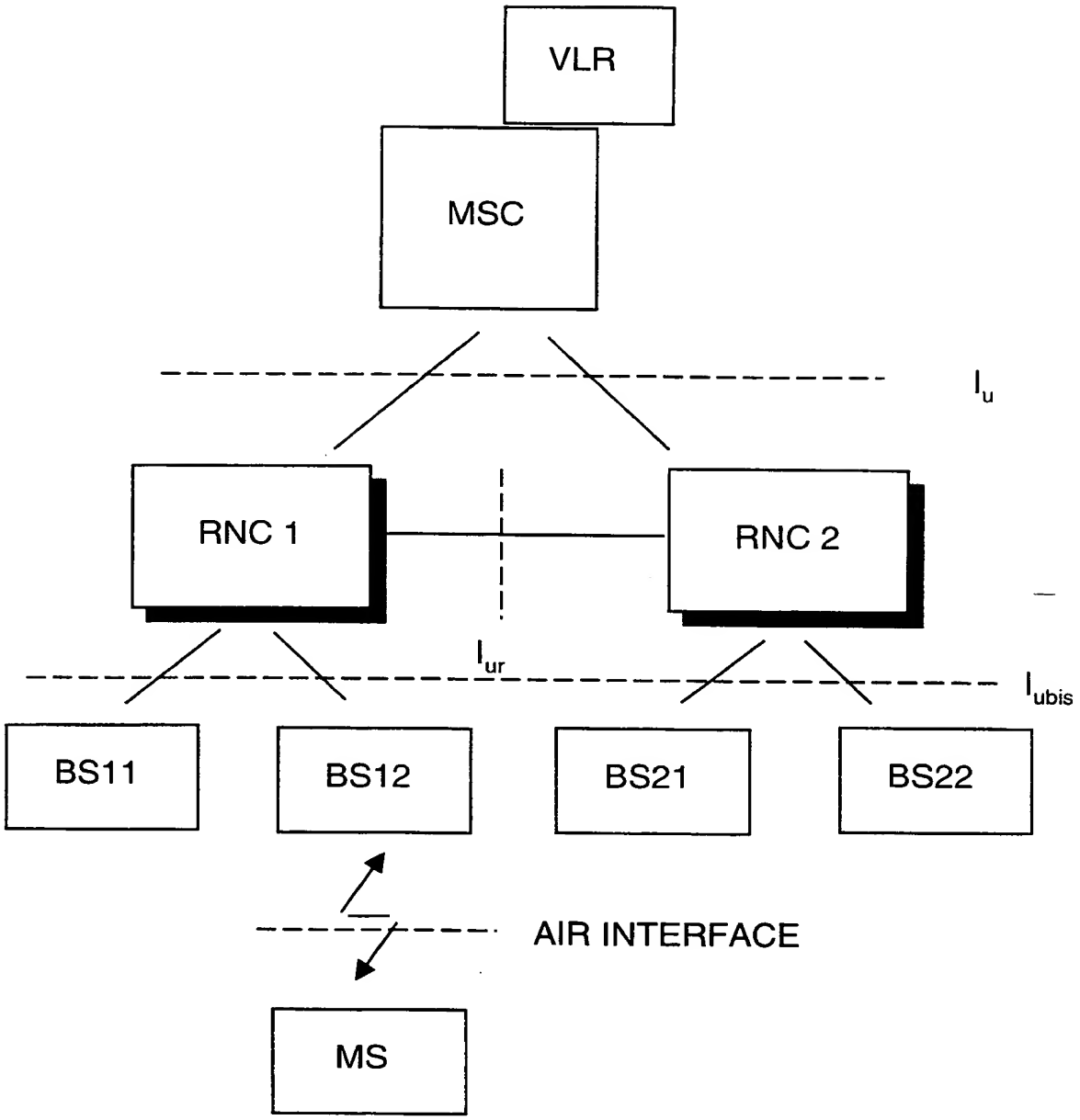
VLR
MSC
I_u
RNC 1
RNC 2
I_{ur}
I_{ubis}
BS11
BS12
BS21
BS22
AIR INTERFACE
MS

FIG. 1

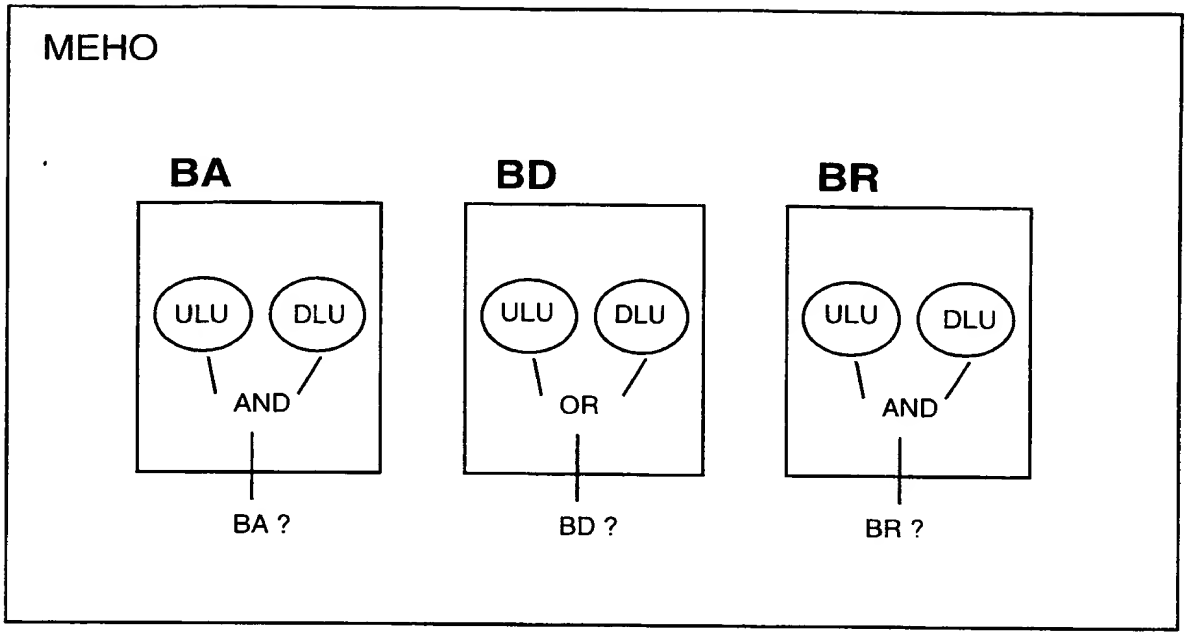

FIG. 2

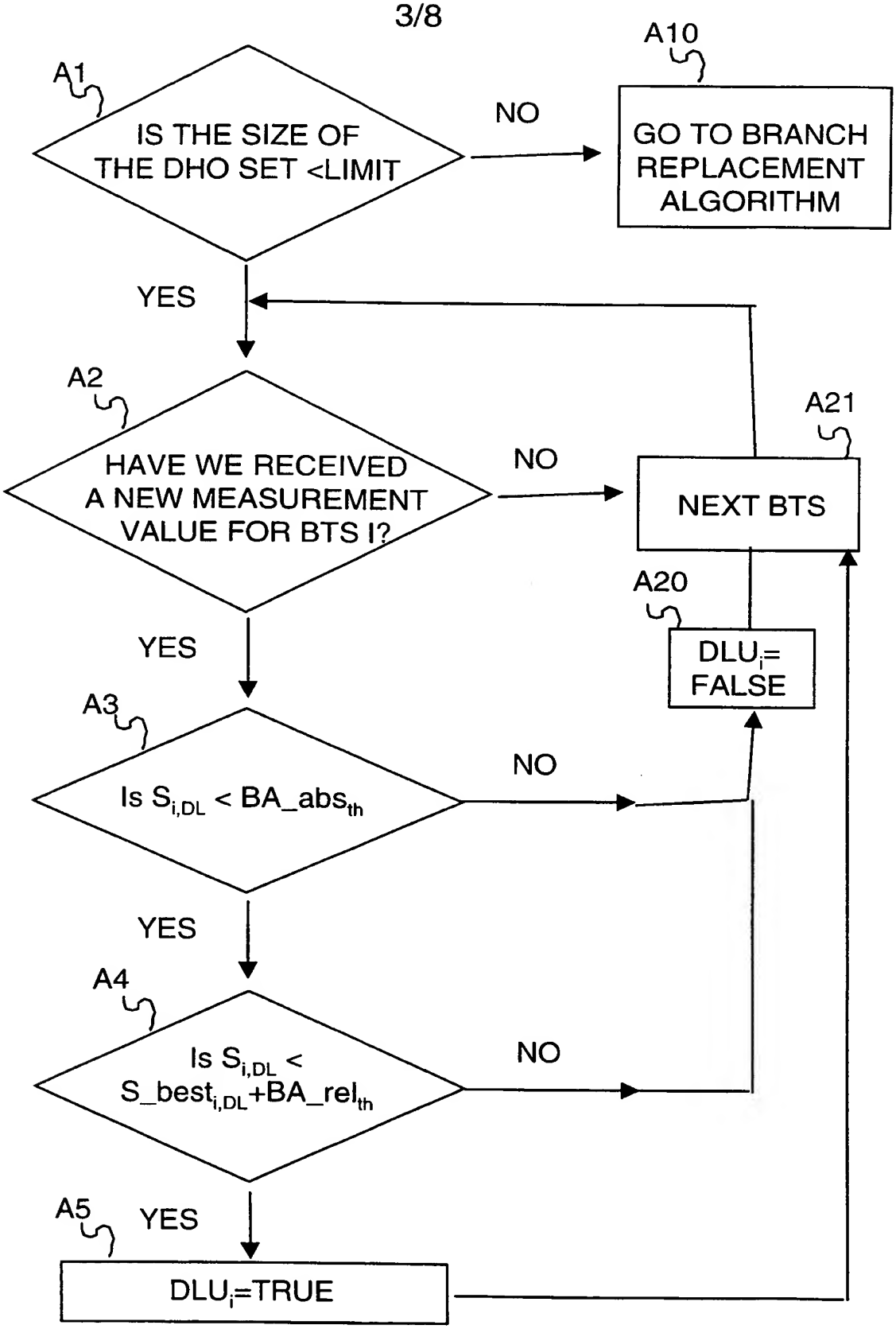
A1
IS THE SIZE OF THE DHO SET <LIMIT
NO
A10
GO TO BRANCH REPLACEMENT ALGORITHM
YES
A2
HAVE WE RECEIVED A NEW MEASUREMENT VALUE FOR BTS I?
NO
A21
NEXT BTS
A20
DLU_i= FALSE
YES
A3
Is S_i,DL < BA_abs_th
NO
YES
A4
Is S_i,DL < S_best_i,DL+BA_rel_th
NO
A5
YES
DLU_i=TRUE

FIG. 3

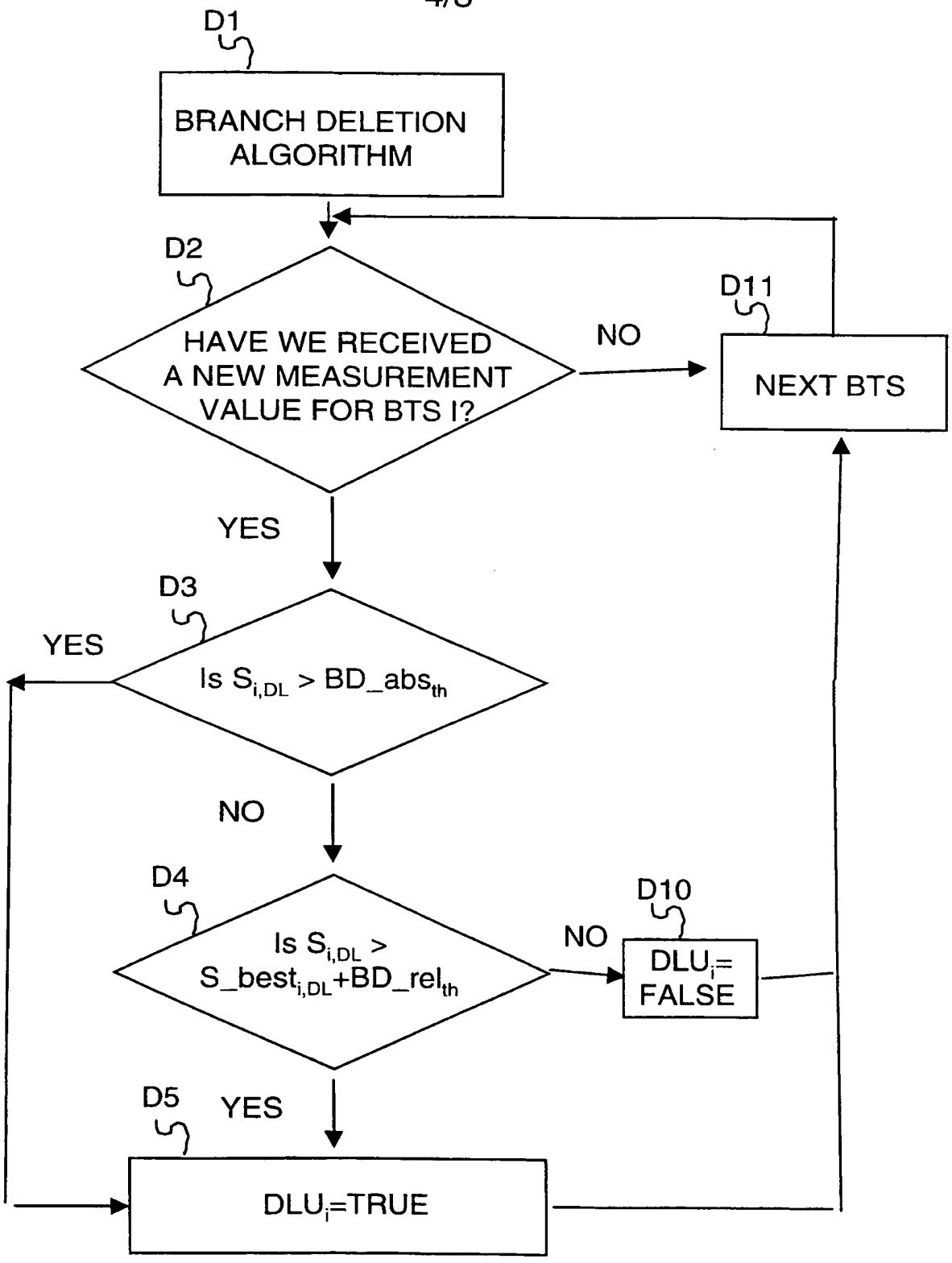
D1
BRANCH DELETION ALGORITHM
D2
HAVE WE RECEIVED A NEW MEASUREMENT VALUE FOR BTS I?
NO
D11
NEXT BTS
YES
D3
YES
Is $S_{i,DL}$ > BD_abs_{th}
NO
D4
Is $S_{i,DL}$ > $S\_best_{i,DL}$+BD_rel_{th}
NO
D10
DLU_i= FALSE
D5
YES
DLU_i=TRUE

FIG. 4

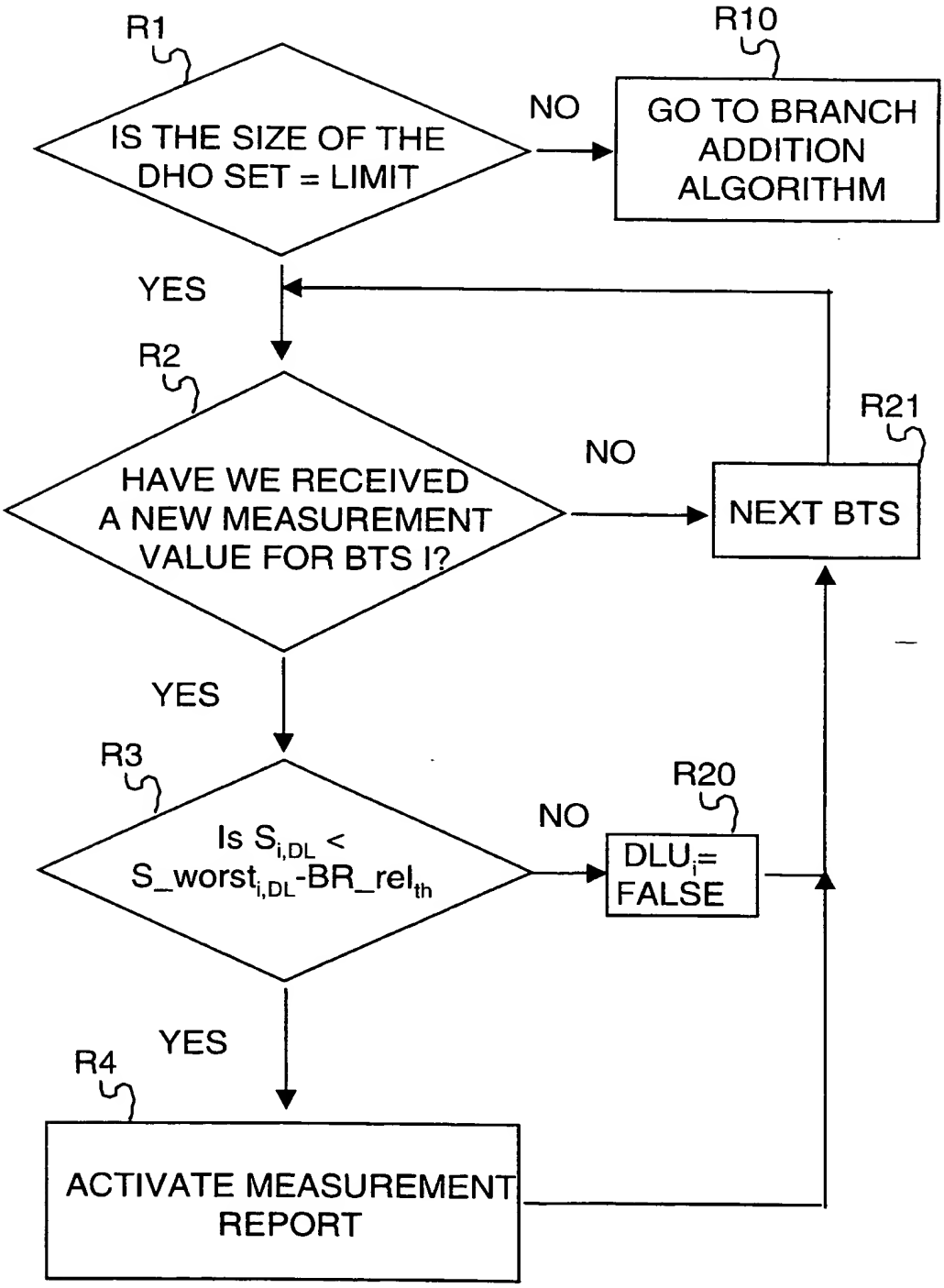
R1
IS THE SIZE OF THE DHO SET = LIMIT
NO
R10
GO TO BRANCH ADDITION ALGORITHM
YES
R2
HAVE WE RECEIVED A NEW MEASUREMENT VALUE FOR BTS I?
NO
R21
NEXT BTS
YES
R3
Is $S_{i,DL}$ < $S\_worst_{i,DL}$-BR_rel_{th}
NO
R20
DLU_i= FALSE
YES
R4
ACTIVATE MEASUREMENT REPORT

FIG. 5

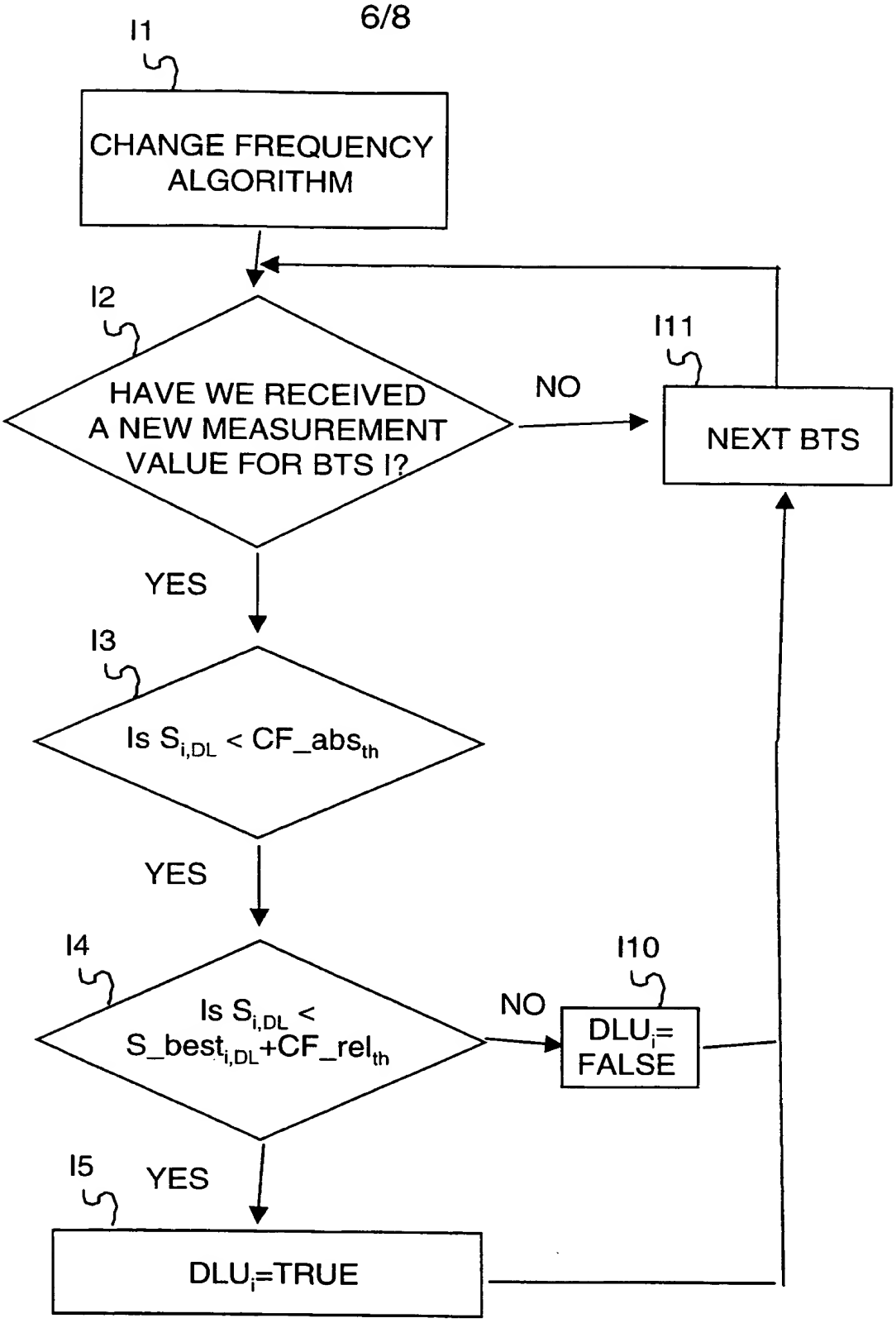
I1
CHANGE FREQUENCY ALGORITHM
I2
HAVE WE RECEIVED A NEW MEASUREMENT VALUE FOR BTS I?
NO
I11
NEXT BTS
YES
I3
Is $S_{i,DL}$ < CF_abs_{th}
YES
I4
Is $S_{i,DL}$ < $S\_best_{i,DL}$+CF_rel_{th}
NO
I10
DLU_i= FALSE
I5
YES
DLU_i=TRUE

FIG. 6

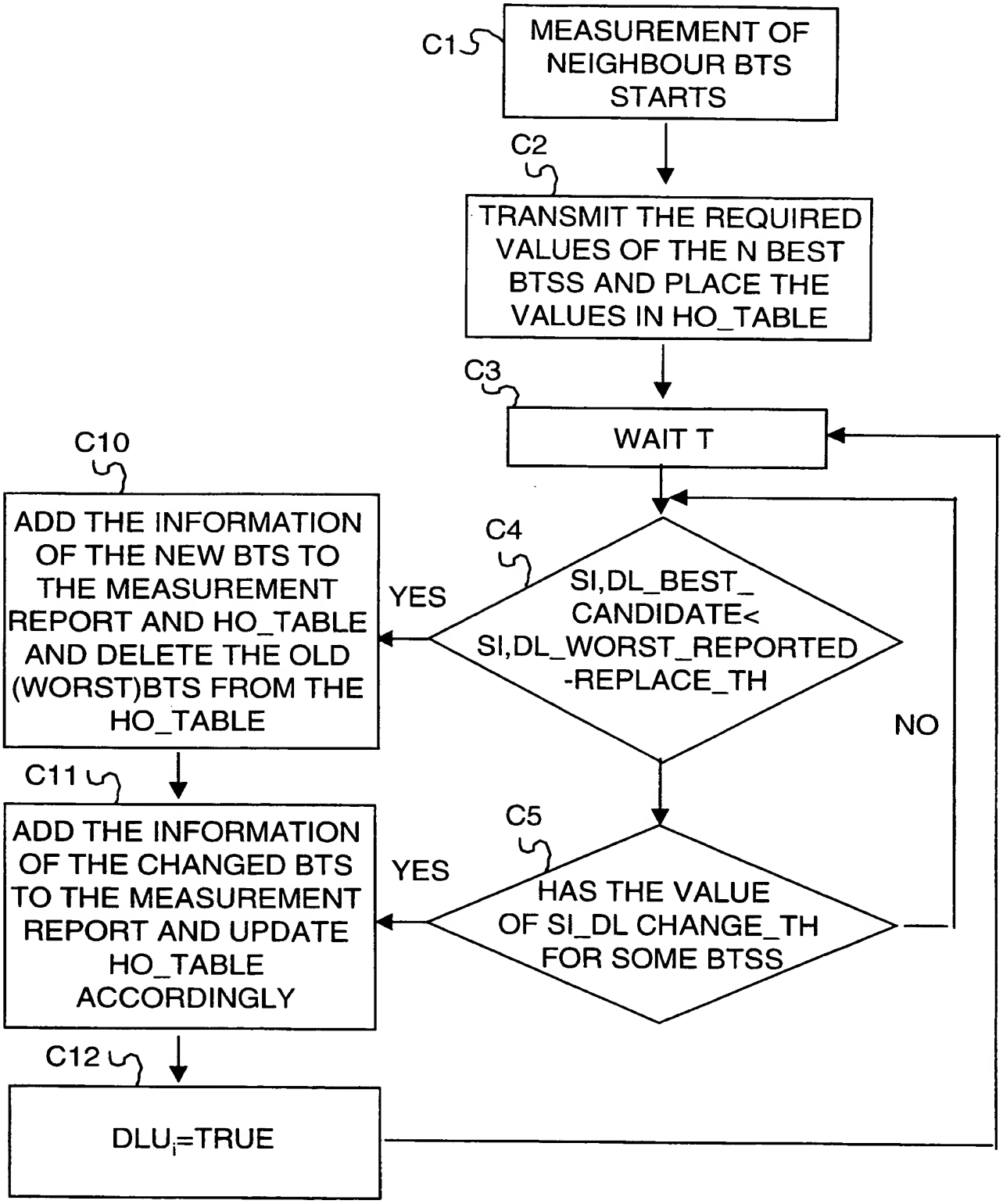
C1
MEASUREMENT OF NEIGHBOUR BTS STARTS
C2
TRANSMIT THE REQUIRED VALUES OF THE N BEST BTSS AND PLACE THE VALUES IN HO_TABLE
C3
WAIT T
C4
SI,DL_BEST_ CANDIDATE< SI,DL_WORST_REPORTED -REPLACE_TH
YES
NO
C10
ADD THE INFORMATION OF THE NEW BTS TO THE MEASUREMENT REPORT AND HO_TABLE AND DELETE THE OLD (WORST)BTS FROM THE HO_TABLE
C11
ADD THE INFORMATION OF THE CHANGED BTS TO THE MEASUREMENT REPORT AND UPDATE HO_TABLE ACCORDINGLY
C5
HAS THE VALUE OF SI_DL CHANGE_TH FOR SOME BTSS
YES
C12
DLU$_i$=TRUE

FIG. 7

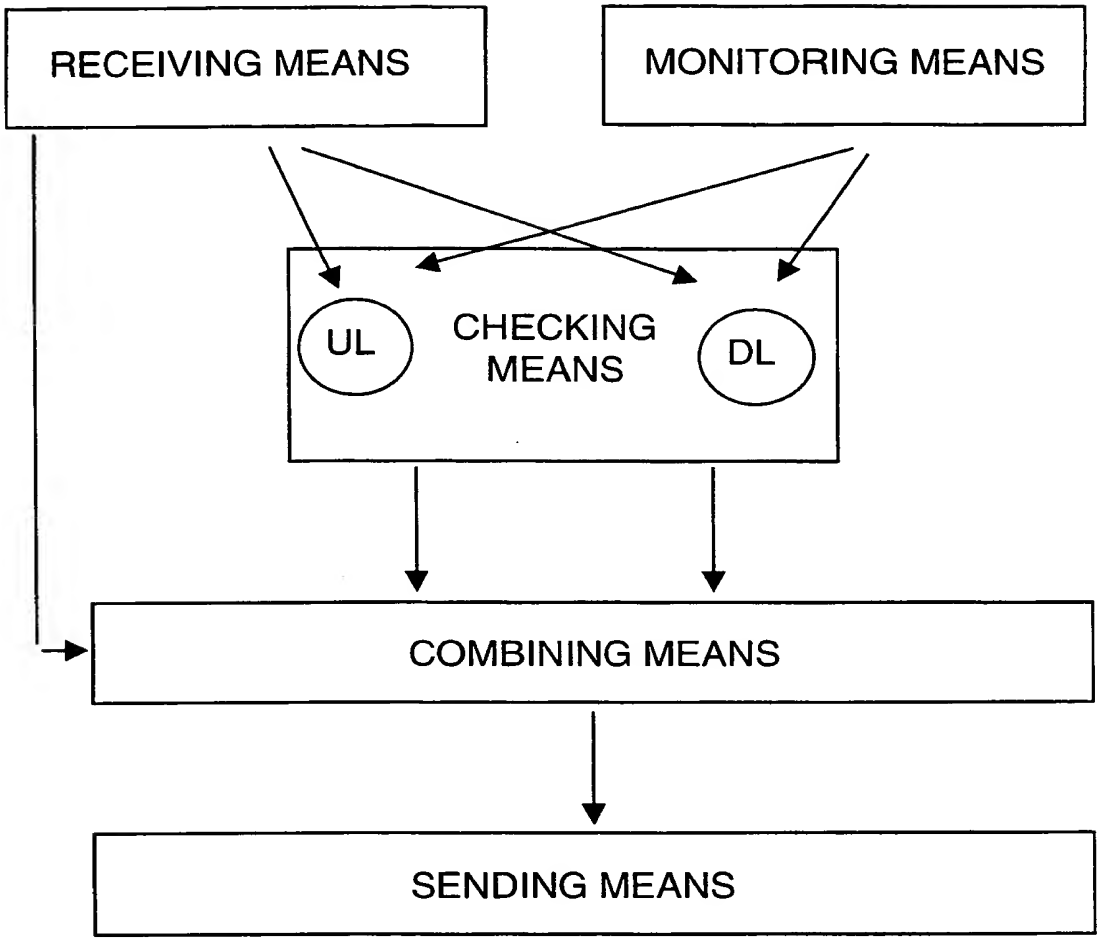
RECEIVING MEANS
MONITORING MEANS
UL
CHECKING MEANS
DL
COMBINING MEANS
SENDING MEANS

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 99/00095

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/38
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9504419 A1 (BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY), 9 February 1995 (09.02.95), page 3, line 26 - page 5, line 20; page 9, line 20 - page 10, line 6; page 11, line 15 - page 12, line 24 --	1,22
A	US 5594949 A (CLAES H. ANDERSSON ET AL), 14 January 1997 (14.01.97), column 6, line 26 - column 7, line 7 --	1,22
P,A	WO 9857512 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 17 December 1998 (17.12.98), page 4, line 9 - line 11; page 4, line 19 - line 29 -- --------	1,22

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 July 1999	28 -07- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Jaana Raivio/mj Telephone No. +46 8 782 25 00

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/FI 99/00095

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9504419 A1	09/02/95	AU 680281 B	24/07/97
		AU 7270094 A	28/02/95
		CA 2168256 A	09/02/95
		CN 1128094 A	31/07/96
		EP 0711482 A	15/05/96
		FI 960389 A	29/01/96
		JP 9501284 T	04/02/97
		NZ 269203 A	27/07/97
		SG 47621 A	17/04/98
US 5594949 A	14/01/97	US 5375123 A	20/12/94
WO 9857512 A1	17/12/98	AU 8046298 A	30/12/98

PATENTTI- JA REKISTERIHALLITUS

VÄLIPÄÄTÖS

09.02.99

09/622241

526 Rec'd PCT/PTO 15 AUG 2000

Nokia IPR-osasto

PL 226

00045 Nokia Group

Patenttihakemus nro:	980358
Luokka:	H 04Q / JSA
Hakija:	Nokia Telecommunications Oy
Asiamies:	Nokia IPR-osasto
Asiamiehen viite:	14231
Määräpäivä	09.08.99

Patenttihakemuksen numero ja luokka on mainittava kirjelmässänne PRH:lle

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Suoritetussa tutkimuksessa ei tullut esiin estettä hakemuksen hyväksynnälle. Hakijaa kehotetaan toimittamaan virastoon englannin kielellä jätetystä hakemuksesta PL 8 § 5 mom mukainen käännös (PA 3 § 1 mom).

Esimerkkinä tutkimuksessa esille tulleista julkaisuista liitetään oheen hakijan aiempi hakemusjulkaisu WO 97/08911, jossa esitetyssä ratkaisussa matkaviestin ohjaa yhteysvastuun vaihtotilanteissa aktiivisten tukiasemien joukkoon kuuluvien tukiasemien lähetystä päälle ja pois, niin että pehmeä yhteysvastuun vaihto saadaan joutuisammaksi kovan yhteysvastuun vaihdon tapaan.

PATENTTI- JA REKISTERIHALLITUS

Tutkijainsinööri Jukka Saranka
Puhelin: (09) 69395394

J Saranka

Lausumanne huomautusten johdosta on annettava viimeistään yllämainittuna määräpäivänä. Jollette ole antanut lausumaanne virastoon viimeistään mainittuna määräpäivänä tai ryhtynyt toimenpiteisiin tässä välipäätöksessä esitettyjen puutteellisuuksien korjaamiseksi, jätetään hakemus sillensä (patenttilain 15 §). Sillensä jätetty hakemus otetaan uudelleen käsiteltäväksi, jos Te neljän kuukauden kuluessa määräpäivästä annatte lausumanne tai ryhdytte toimenpiteisiin esitettyjen puutteellisuuksien korjaamiseksi ja samassa ajassa suoritatte vahvistetun maksun, 320 mk hakemuksen ottamisesta uudelleen käsiteltäväksi. Jos lausumanne on annettu virastoon oikeassa ajassa, mutta esitettyjä puutteellisuuksia ei ole siten korjattu, että hakemus voitaisiin hyväksyä, se hylätään, mikäli virastolla ei ole aihetta antaa Teille uutta välipäätöstä (patenttilain 16 §). Uusi keksinnön selitys, siihen tehdyt lisäykset ja uudet patenttivaatimukset on aina jätettävä kahtena kappaleena ja tällöin on otettava huomioon patenttiasetuksen 19 §.

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Pankki: PSP 800015-47908

PATENT COOPERATION TREA

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

05. 2000

52185-06

PCT

To:

JOHANSSON, Folke
NOKIA CORPORATION
P.O. Box 319
00045 Nokia Group
FINLANDE

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT
(PCT Rule 71.1)

Date of mailing *(day/month/year)*	16.05.2000
Applicant's or agent's file reference 14231 WO	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/FI99/00095	09/02/1999	17/02/1998

Applicant
NOKIA NETWORKS OY et al.

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices) (Article 39(1)) (see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/	Authorized officer
European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Cremona, P Tel.+49 89 2399-8244

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
14231 WO		
International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/FI99/00095	09/02/1999	17/02/1998
International Patent Classification (IPC) or national classification and IPC H04Q7/38		
Applicant NOKIA NETWORKS OY et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement
   - VI ☐ Certain documents cited
   - VII ☒ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
09/09/1999	16.05.2000
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Le Bras, P Telephone No. +49 89 2399 8819

Form PCT/IPEA/409 (cover sheet) (January 1994)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/FI99/00095

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-3,5-14	as published			
4,4a	as received on	19/04/2000	with letter of	13/04/2000

Claims, No.:

1-23	as published

Drawings, sheets:

1/8-8/8	as published

2. The amendments have resulted in the cancellation of:

☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-23
	No:	Claims	
Inventive step (IS)	Yes:	Claims	1-23
	No:	Claims	
Industrial applicability (IA)	Yes:	Claims	1-23
	No:	Claims	

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. The invention relates to measurement reporting in a telecommunication system. In cellular telecommunication networks, soft hand-over generally improve the overall performance of the network ressources. It may however have a negative impact on capacity of the network due to unnecessary branches between the MS and the base stations.
The principle of dynamic level thresholds for active set management is known to partially solve he problem.
The method of claim 1 and the mobile station of claim 22 still improve the management of the compromise between the efficiency of the hand-over algorithms and the usage of radio resources by defining triggers for radio signal parameters for sending a measurement report separately for downlink and uplink directions.

   The nearest cited prior art WO9802010 discloses a process whereby measurements ondownlink and uplink parameters are used for adaptative allocation of frequencies or channels, however no hints is given as to the use of the measurements to improve the network signaling ressources including hand-over management.

   Therefore it isconsidered that claims 1 and 22 complywith the requirementsof Article 33(2) and 33(3) PCT.

2. Dependent claims 2 to 21 and 23 comprise additional features of the inventive method and apparatus claim they are appended to and as such comply with the requirements of Article 33(2) and (3) PCT.

Re Item VII

Certain defects in the international application

1. The features of the claims have not been provided with reference signsplaced in parantheses (Rule 6.2 (b) PCT).

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

PCT

To:

Johansson Folke
c/o Nokia Corporation
P.O.Box 226
FIN-00045 NOKIA GROUP
Finland

02.09.99

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

Date of mailing *(day/month/year)*	28-07-1999
Applicant's or agent's file reference: 14231 WO	FOR FURTHER ACTION See paragraphs 1 and 4 below
International application No.: PCT/FI99/00095	International filing date *(day/month/year)*: 09-02-1999
Applicant: Nokia Telecommunications OY et al	

1. [X] The applicant is hereby notified that the international search report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:

The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally 2 months from the date of transmittal of the international search report: however, for more details, see the notes on the accompanying sheet.

Where? To the International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland
Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see notes on the accompanying sheet.

2. [ ] The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. [ ] **With regard to the protest against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:**

[ ] the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

[ ] no decision has been made yet on the protest: the applicant will be notified as soon as a decision is made.

4. **Further action(s):** The applicant is reminded of the following:

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90*bis*.1 and 90*bis*.3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase until 30 months from the priority date (in some Offices even later).

Within **20 months** from the priority date, the applicant must perform the prescribed acts for entry into the national phase before all designated Offices which have not been elected within 19 months from the priority date or could not be elected because they are not bound by Chapter II.

Name and mailing address of the ISA/ Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. 08-667 72 88 Telex 17978 PATOREG-S	Authorized officer Jessica Kumlin Telephone No. 08-782 25 00

Form PCT/ISA/220 (January 1994)

(See notes on accompanying sheet)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 14231 WO	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/FI 99/00095	International filing date *(day/month/year)* 9 February 1999	(Earliest) Priority Date *(day/month/year)* 17 February 1998
Applicant Nokia Telecommunications Oy et al		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

[x] It is also accompanied by a copy of each prior art document cited in this report.

1. [ ] Certain claims were found unsearchable (See Box I).

2. [ ] Unity of invention is lacking (See Box II).

3. [ ] The international application contains disclosure of a nucleotide and/or amino acid sequence listing and the international search was carried out on the basis of the sequence listing
   - [ ] filed with the international application.
   - [ ] furnished by the applicant separately from the international application,
     - [ ] but not accompanied by a statement to the effect that it did not include matter going beyond the disclosure in the international application as filed.
   - [ ] transcribed by this Authority.

4. With regard to the title,
   - [x] the text is approved as submitted by the applicant.
   - [ ] the text has been established by this Authority to read as follows:

5. With regard to the abstract,
   - [x] the text is approved as submitted by the applicant.
   - [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is:
   Figure No. 2
   - [x] as suggested by the applicant.
   - [ ] because the applicant failed to suggest a figure.
   - [ ] because this figure better characterizes the invention.
   - [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

Int[redacted]onal application No.
PCT/FI 99/00095

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04Q 7/38
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A ✓	WO 9504419 A1 (BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY), 9 February 1995 (09.02.95), page 3, line 26 - page 5, line 20; page 9, line 20 - page 10, line 6; page 11, line 15 - page 12, line 24 --	1,22
A ✓	US 5594949 A (CLAES H. ANDERSSON ET AL), 14 January 1997 (14.01.97), column 6, line 26 - column 7, line 7 --	1,22
P,A ✓	WO 9857512 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 17 December 1998 (17.12.98), page 4, line 9 - line 11; page 4, line 19 - line 29 -- -------	1,22

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 July 1999	28 -07- 1999
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Jaana Raivio/mj Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT
Information on patent family members

01/07/99

International application No.
PCT/FI 99/00095

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9504419 A1	09/02/95	AU 680281 B	24/07/97
		AU 7270094 A	28/02/95
		CA 2168256 A	09/02/95
		CN 1128094 A	31/07/96
		EP 0711482 A	15/05/96
		FI 960389 A	29/01/96
		JP 9501284 T	04/02/97
		NZ 269203 A	27/07/97
		SG 47621 A	17/04/98
US 5594949 A	14/01/97	US 5375123 A	20/12/94
WO 9857512 A1	17/12/98	AU 8046298 A	30/12/98

PATENT COOPERATION TREATY

PCT SL

From the INTERNATIONAL BUREAU

To:

JOHANSSON, Folke
Nokia Corporation
P.O. Box 319
FIN-00045 Nokia Group
FINLANDE

25 04. 00
☐ Comp. record
☐ Prior Art/Salo
☐ Prior Art/IDS
☐ Attorney
☐ CC:

NOTIFICATION OF THE RECORDING OF A CHANGE

(PCT Rule 92bis.1 and Administrative Instructions, Section 422)

Date of mailing (day/month/year)	
11 April 2000 (11.04.00)	
Applicant's or agent's file reference	**IMPORTANT NOTIFICATION**
14231 WO	
International application No.	**International filing date (day/month/year)**
PCT/FI99/00095	09 February 1999 (09.02.99)

1. The following indications appeared on record concerning:

☐ the applicant ☐ the inventor ☒ the agent ☐ the common representative

Name and Address	State of Nationality	State of Residence
JOHANSSON, Folke Nokia Corporation P.O. Box 226 FIN-00045 Nokia Group Finland		
	Telephone No.: +358-9-18071	
	Facsimile No.: +358-9-1807 593	
	Teleprinter No.:	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☐ the person ☐ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address	State of Nationality	State of Residence
JOHANSSON, Folke Nokia Corporation P.O. Box 319 FIN-00045 Nokia Group Finland		
	Telephone No.: +358-9-51121	
	Facsimile No.: +358-9-511 64604	
	Teleprinter No.:	

3. Further observations, if necessary:

4. A copy of this notification has been sent to:

☒ the receiving Office
☐ the International Searching Authority
☒ the International Preliminary Examining Authority
☐ the designated Offices concerned
☒ the elected Offices concerned
☐ other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Jean-Marie McAdams
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

Form PCT/IB/306 (March 1994)

003219578

WO 99/43177
PCT/FI99/00095

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

To:
JOHANSSON, Folke
Nokia Corporation
P.O. Box 226
FIN-00045 Nokia Group
FINLANDE

Date of mailing (day/month/year) 26 August 1999 (26.08.99)	03. 09. 99
Applicant's or agent's file reference 14231 WO	**IMPORTANT NOTICE**

International application No.	**International filing date** (day/month/year)	**Priority date** (day/month/year)
PCT/FI99/00095	09 February 1999 (09.02.99)	17 February 1998 (17.02.98)

Applicant
NOKIA TELECOMMUNICATIONS OY et al

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
   AU,CN,EP,IL,JP,KP,KR,US

   In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
   AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,CA,CH,CU,CZ,DE,DK,EA,EE,ES,FI,GB,GD,GE,GH,GM,HR,HU,
   ID,IN,IS,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MD,MG,MK,MN,MW,MX,NO,NZ,OA,PL,PT,RO,RU,SD,
   SE,SG,SI,SK,SL,TJ,TM,TR,TT,UA,UG,UZ,VN,YU,ZW
   The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
   26 August 1999 (26.08.99) under No. WO 99/43177

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, **a demand for international preliminary examination** must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the **national phase**, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer
J. Zahra

Telephone No. (41-22) 338.83.38

Continuation of Form PCT/IB/308

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

Date of mailing (day/month/year)	IMPORTANT NOTICE
26 August 1999 (26.08.99)	
Applicant's or agent's file reference	**International application No.**
14231 WO	PCT/FI99/00095

The applicant is hereby notified that, at the time of establishment of this Notice, the time limit under Rule 46.1 for making amendments under Article 19 has not yet expired and the International Bureau had received neither such amendments nor a declaration that the applicant does not wish to make amendments.

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

INFORMATION CONCERNING ELECTED OFFICES NOTIFIED OF THEIR ELECTION

(PCT Rule 61.3)

To:

JOHANSSON, Folke
Nokia Corporation
P.O. Box 226
FIN-00045 Nokia Group
FINLANDE

01. 11. 99

Date of mailing (day/month/year) 25 October 1999 (25.10.99)	
Applicant's or agent's file reference 14231 WO	**IMPORTANT INFORMATION**

International application No.	**International filing date** (day/month/year)	**Priority date** (day/month/year)
PCT/FI99/00095	09 February 1999 (09.02.99)	17 February 1998 (17.02.98)

Applicant
NOKIA TELECOMMUNICATIONS OY et al

1. The applicant is hereby informed that the International Bureau has, according to Article 31(7), notified each of the following Offices of its election:

   AP :GH,GM,KE,LS,MW,SD,SZ,UG,ZW
   EP :AT,BE,CH,CY,DE,DK,ES,FI,FR,GB,GR,IE,IT,LU,MC,NL,PT,SE
   National :AU,BG,BR,CA,CN,CZ,DE,IL,JP,KP,KR,MN,NO,NZ,PL,RO,RU,SE,SK,US

2. The following Offices have waived the requirement for the notification of their election; the notification will be sent to them by the International Bureau only upon their request:

   EA :AM,AZ,BY,KG,KZ,MD,RU,TJ,TM
   OA :BF,BJ,CF,CG,CI,CM,GA,GN,GW,ML,MR,NE,SN,TD,TG
   National :AL,AM,AT,AZ,BA,BB,BY,CH,CU,DK,EE,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,
   IN,IS,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MD,MG,MK,MW,MX,PT,SD,SG,SI,SL,TJ,TM,
   TR,TT,UA,UG,UZ,VN,YU,ZW

3. The applicant is reminded that he must enter the "national phase" **before the expiration of 30 months from the priority date** before each of the Offices listed above. This must be done by paying the national fee(s) and furnishing , if prescribed, a translation of the international application (Article 39(1)(a)), as well as, where applicable, by furnishing a translation of any annexes of the international preliminary examination report (Article 36(3)(b) and Rule 74.1).

   Some offices have fixed time limits expiring later than the above-mentioned time limit. For detailed information about the applicable time limits and the acts to be performed upon entry into the national phase before a particular Office, see Volume II of the PCT Applicant's Guide.

   The entry into the European regional phase is postponed **until 31 months from the priority date** for all States designated for the purposes of obtaining a European patent.

The International Bureau of WIPO
34, chemin des Colombettes
1211 Geneva 20, Switzerland

Facsimile No. (41-22) 740.14.35

Authorized officer:
F. Baechler

Telephone No. (41-22) 338.83.38

whose beacon signal is above T1 will not improve performance but will utilize more network resources. In these situations a higher value of T2 is used.

After detecting a base station signal above T2, the MS will report it back to the network. The network will then set up the handover resources and order the MS to coherently demodulate the signal of this additional branch.

Beacons can be dropped from the active set according to the same principles. When the beacon strength decreases below a dynamic threshold T3, the handover connection is removed, and the beacon is moved back to the candidate set. The threshold T3 is a function of the total energy of beacons in the active set. When beacons in the active set are weak, removal a branch, even a weak one, will decrease performance. In these situations, a relatively low value of T3 is used. When there is one or more dominant branches, removal of a weaker signal will not decrease performance but will make the utilization of the network resources more efficient. In these situations a higher value of T3 is used. Branches not contributing sufficiently to the total received energy will be dropped. When further decreasing below a static threshold T4 a beacon is removed from the candidate set.

To be able to control the connection, the network needs in different situations different kinds and different amount of measurement information. The more information is sent the more efficient the handover algorithm are. However, the more information the mobile station sends the network, the more radio resources are spent. Thus, the measurement reporting schemes according to prior art are always compromises between the efficiency of the handover algorithms and the usage of radio resources.

As the usage of mobile telecommunication systems and multimedia applications requiring large bandwidths is growing the present methods are no longer sufficient, thus limiting the performance of the mobile telecommunication networks. The objective of the present invention is a flexible measurement reporting scheme which solves this problem.

Summary of the invention

The basic idea of this invention is to define triggers, e.g. threshold values for radio signal parameters, for sending a measurement report separately for downlink and uplink directions. In addition, it is specified how